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AUTHOR Moche, Dinah
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ABSTRACT

This booklet is designed to introduce young people, their parents, teachers, and advisers to various fields of and possible career opportunities in physics. The colorfully illustrated booklet, aimed particularly at junior high school students, highlights the work and experiences of several young physicists. Although physics is not usually taught until the last year of high school, the necessary mathematical preparation is decided at the junior high school level. Therefore, this booklet seeks to inspire junior high school students, who might otherwise avoid technical subjects, to study all the mathematics and science courses they can. (JN)

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PHYSICS IN YOUR FUTURE

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BY DINAH MOCHÉ

FOR THE COMMITTEE
ON THE STATUS OF
WOMEN IN PHYSICS
OF THE AMERICAN
PHYSICAL SOCIETY

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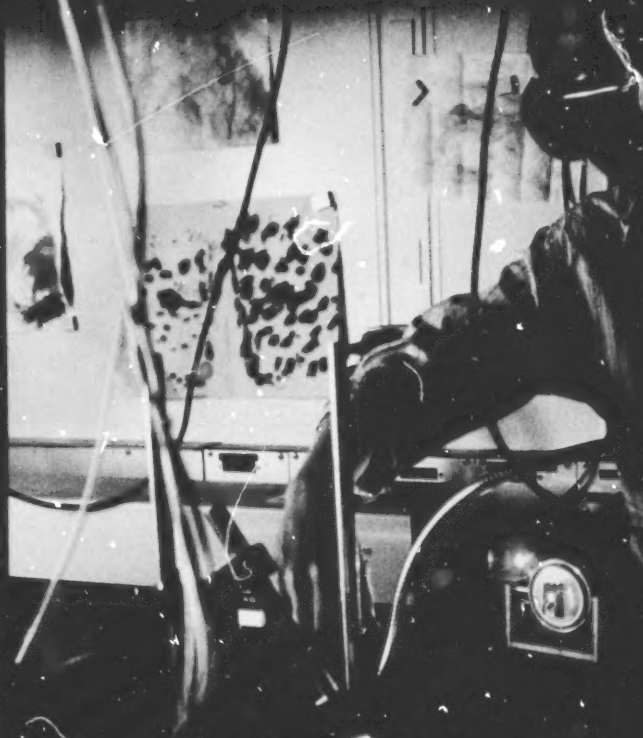
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TO THE EDUCATIONAL RESOURCES
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Choosing a career is a big decision. Most people work as long as 50 years. It's very important to find work that you'll enjoy. You'll have a great selection of rewarding careers to choose from if you study math and science. This booklet describes some of your possibilities.



PHYSICS IS THE BASIS OF SCIENCE AND TECHNOLOGY.

It deals with how and why matter and energy act as they do.

The laws of physics precisely describe force and motion, gravity, electricity, magnetism, sound, light and heat. They help you understand the physical world and develop products that meet human needs.

Mastering physics is challenging. You must work with other people as well as alone. You learn how to solve problems, observe things carefully, make measurements and keep accurate records.

You can use these valuable skills the rest of your life. They open doors to many good jobs.

Physicists ask questions about the physical world and try to find exact answers. They are creative and persistent.

Some do basic research. Their aim is to increase our knowledge of the universe. Others do applied research. They use basic knowledge to solve human problems such as food and energy supply, environmental protection, transportation, communication and defense.

Over 40,000 physicists work in industry, educational institutions, government and medical centers today. Most are active scientists and engineers. They do research, development, administration and teach. The rest use their physics background in work such as publishing, sales, law, accounting and medicine.

How much money beginning physicists earn depends on their education, type of employer and responsibilities. Their salaries are generally good. You can get the latest salary information from the Committee on the Status of Women in Physics (see back cover for address and telephone number).

You've probably seen TV shows and movies that have influenced your thoughts about scientists. Now meet some real people who are physicists. Find out what they



The laws of physics govern everything in the universe from the tiniest bits of matter to the hugest stars. You must understand them to design popular products such as TV's, stereos, cameras and computers.

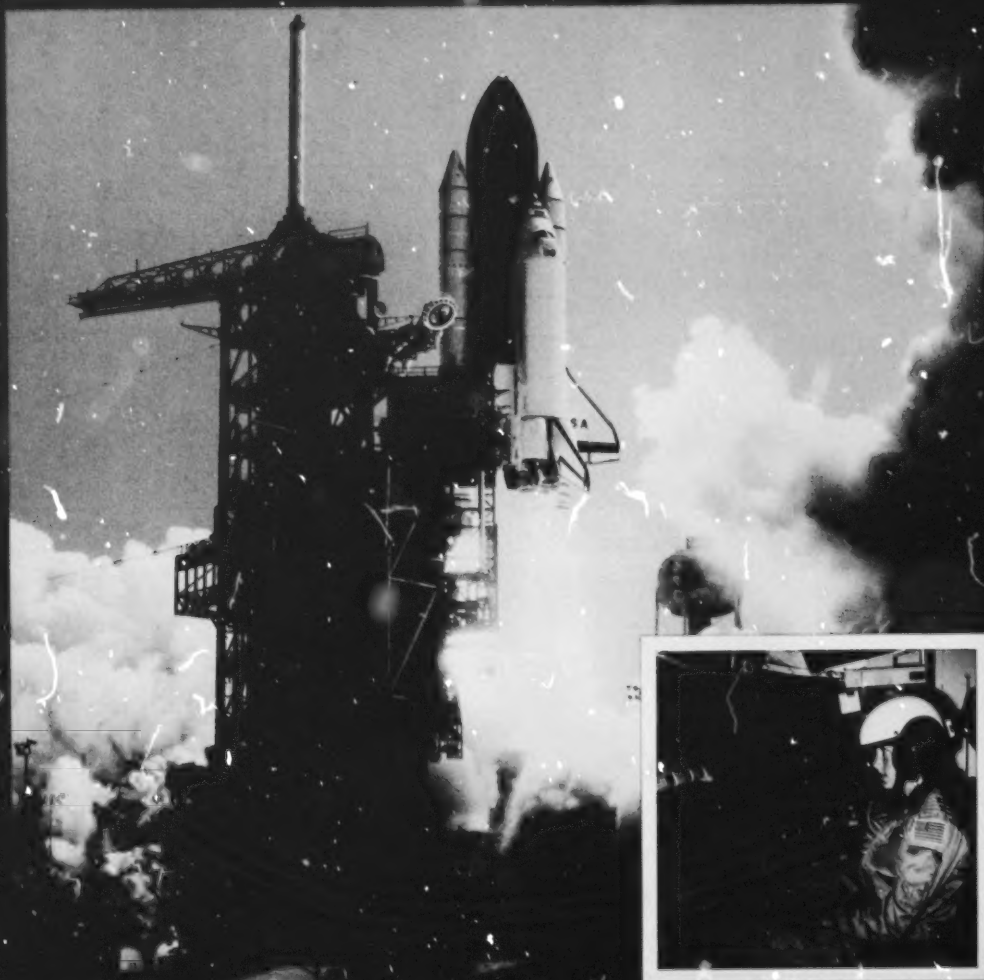
actually do and what kind of people they truly are. Then see if you can picture yourself with a career in science.



Theoretical physicists use mathematical ideas and tools. Experimental physicists work in laboratories. Often both combine efforts on a project.

Space shuttles transport people, material and equipment to and from Earth orbit. "It takes us more than a

year to get ready for a mission that lasts a few days or weeks," Sally says. Crews train about four hours daily in a mission simulator that looks, feels and performs like a real space shuttle. They get familiar with some 2,000 displays and controls and practice liftoffs, ascents to orbit, aborts, descents and landings. "With each session we have an hour briefing beforehand and reading about various shuttle systems afterward."



"P HYSICS IS IMPORTANT—IT TAUGHT ME HOW TO APPROACH PROBLEMS."

"We have to learn a lot of technical material in a hurry," observes Dr. Sally K. Ride.

Astronauts work on the entire space shuttle program. Between missions, they have technical assignments in science, hardware development and flight operations. They also make informative television, radio and personal appearances worldwide.

"First I worked on the remotely controlled arm," says Sally.

"Designers wanted it to lift payloads out of the cargo bay and catch them in space.

"I 'flew' the arm with a simulator and told the engineers how it performed as they developed it. We went over necessary changes."

Next Sally served as CAPCOM (capsule communicator) for the second and third space shuttle flights. "That's the person in mission control who talks to the crew during a flight. We practiced for about a year and a half while they were training."

She was selected for the seventh flight crew. A mission specialist, she runs experiments. As the flight engineer, she helps the pilot and the commander during launch and entry.

Astronauts must have a college degree in engineering, science or math. Sally completed a Ph.D. in physics. Her husband, a fellow astronaut, majored in physics and astronomy.



People feel weightless when NASA's KC-135 aircraft flies curves. "We go up in the plane mainly to check that things work in zero gravity," Sally explains. "Our flight clothes have lots of pockets to hold tools so they don't float away when we're not using them."

Sally grew up in southern California. She remembers, "Tennis was really my life.

"In junior and senior high I did a lot of practicing, played in state and national tournaments all year, spent the summers travelling in the midwest or on the east coast playing, and my friends were tennis players."

At Westlake High School Sally took history, English and all the science courses offered.

"I planned to go into astronomy in college. My counselor advised me to start with a physics course since it was a prerequisite. I started off that way and I liked it!"

Sally (left) was the first American woman on a space shuttle flight crew. To become eligible for the assignment, she had to successfully complete a year of training and evaluation. "A short course in water survival prepares us for emergency ejection from our training aircraft," she notes.

PHYSICS HELPS IN THE BATTLE AGAINST CANCER.

Gamma and x rays carry tremendous energy. They can damage or destroy living cells. They are used in cancer therapy to kill deadly growths and to stop their spread in patients.

Gwendolyn C. King computes treatment plans that make the radiation strike just the tumor and not healthy organs nearby.



Gwen is an engineer-physicist at Howard University Hospital in Washington, D.C. "I monitor the patients' and staff's exposure to radiation," she says.

"Medical teams need a physicist to make sure that radiation is used safely," she emphasizes.

Sometimes surgeons implant radioisotopes, atomic nuclei that emit radiation, into the problem area. Gwen has a Geiger counter in the operating room to measure radioactivity during and after the implant.

"If there is any emergency, I know what should be done," she declares.

For temporary implants, Gwen places special lead shieldings around patients. She monitors their rooms, bathrooms, linens and telephones to protect visitors and staff. Upon removal, she disposes of the waste safely.

"It's very difficult to watch people suffer," she sighs. "I feel good when we relieve a patient's pain."

How did Gwen prepare for such crucial work?

"I was the first in my family to go to college," she notes proudly.

Gwen was born in St. Kitts, a dreamy island in the British West Indies. "I grew up loving the sea and the mountains and often went swimming, hiking and hunting.

"My grandmother inspired me. She had a village store where I learned to count change and sell. She urged me to get a good education."

Gwen went to St. Theresa Convent High School where religion was most important. Next came a college preparatory school in the island's capital. Then she taught for two years in order to earn tuition for college.

"I was always very good in math," she recalls. When a professor suggested that Gwen become a chemical engineer, she took both physics and chemistry for the first time. "My junior year was tough!"

Howard University recruited her for an intense physics program that summer and the next. After successfully completing it, she returned to earn an M.S. degree in physics. She is now studying computer science to help with her research.



Gwen also checks treatment machines and diagnostic instruments regularly to maintain accuracy.

RESEARCH IS MAKING COMPUTERS BETTER AND CHEAPER.

"I research how to build thousands and thousands of tiny electronic devices on a chip smaller than your fingernail," says Dr. Linda M. Ephrath.

A chip is the "brain cell" of a computer. It is a bit of silicon full of circuit elements that manipulate and store information.

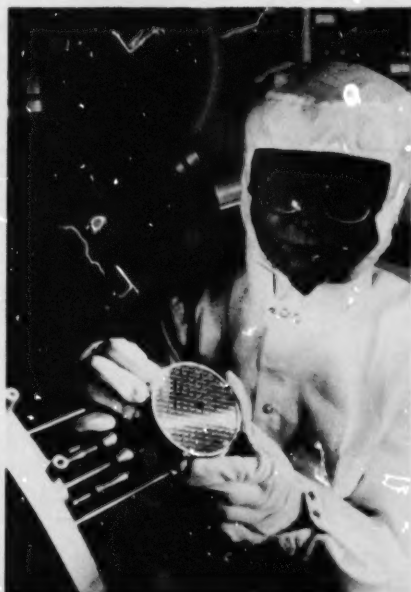
How does Linda put so many minute logic and memory devices on one chip?

Chips are coated with semiconductor films. Patterns for circuits and devices are etched into the film layers.

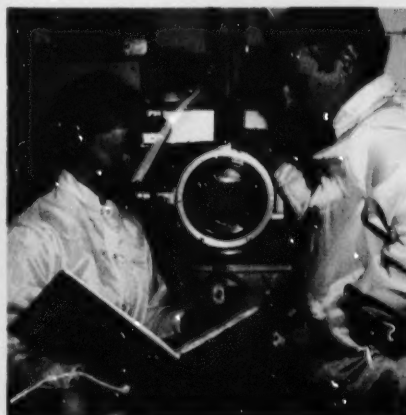
"I'm using and expanding fundamental research in directed etching," Linda explains.

"Reactive ion etching is a new technique. Ions in a plasma react with the films and only etch in the direction you need."

Besides planning and analyzing her own research, Linda is a group manager. She directs the work of others. Frequently she works with managers of related groups, too.



Designers make computers faster and cheaper by putting ever more circuit elements on tinier chips. These chips are processed on silicon wafers like the one pictured here at General Electric.



Sometimes difficult problems arise in the process of fabricating chips. Work stops. "My work makes a real difference," Linda beams. "It feels great to come up with a solution in a crunch!" Linda is pictured in her laboratory at IBM in Yorktown Heights, NY. Behind her is a reactor she designed to etch chips in a plasma. (The plasma appears as a pink-orange glow.)

"Research is most useful when good ideas are put into production," Linda emphasizes.

"Manufacturers select the ideas they'll use. I persuade them to use mine."

Linda is often invited to meetings to speak about her research. She travels around the United States three or four weeks every year. "There's a lot of action in my field in Japan now so I may go there soon," she smiles.

When did Linda decide to be a physicist? "In high school," she recalls.

Linda grew up in Tampa, Florida, and attended public schools there. "I always loved science."

"In fifth grade I bought a microscope and telescope which I used for fun for years. My father expected me to be a nurse. I didn't dream anyone would pay me to do science or even that I'd have to support myself."

Today Linda's parents and husband are proud that she earns a very good salary doing what she enjoys.

“P HYSICS OPENS GOOD JOBS TO YOU,”

explains Ingrid Lapins Frisch. “It gives you important mental discipline and problem solving abilities.”

Ingrid has a B.S. degree in physics. She specializes in aircraft lighting systems.

If an airline wants new lighting equipment for its fleet, Ingrid figures out a way to test a model in her laboratories. She experiments and analyzes the results. She reviews engineering drawings. Then she reports whether the part really works the way its designers claim.



“My tests determine whether or not proposed new lighting equipment is accepted,” Ingrid says. “When parts are first installed, I check them on the airplane. I’m proud that my work makes flying safer for millions of people.” She is a specialist engineer at The Boeing Company in Seattle, WA.

Engineers and suppliers also submit new flight deck hardware to Ingrid for testing. She evaluates the lighting, color and display in general.

“Pilots are fussy about the lights and colors in the flight deck,” Ingrid notes. “Throughout a flight they watch and rely on hundreds of lighted instruments and warning signals. I make sure these give information quickly and accurately without dangerous distraction.”

How did Ingrid get to such an important job?

Ingrid grew up in New York’s economically depressed South Bronx.

“It was very unusual in my neighborhood to excel in schoolwork,” she remembers. “Talented girls often put their whole effort into sports.”

“My parents came here from Europe with high intellectual standards. They expected my brother and me to do well in school. We took advantage of the good education offered by our public schools. I played basketball, volleyball and paddleball and became a popular gym leader, too.”

In her sophomore year in college, Ingrid got a part-time job working in a high energy physics laboratory. She had so much fun that she chose to major in physics.



Interior systems that light a jetliner’s flight deck and passenger cabin have many parts, as do exterior systems such as anti-collision, navigation and landing lights. Ingrid’s job is to make sure that new parts—designed to improve performance—work safely and efficiently before they fly.

I PROBE THE EARTH WITH SOUND SIGNALS."

Previous oil deposits exist under the ocean. Dr. Carol J. Welkie develops remote sensing systems to locate them.

"A seismic source array suspended from a ship fires loudly, like many guns, underwater," she says.

"Sound signals travel down to the sea floor and into the sediments below. Different geological formations return them with characteristics which scientists decipher to find out what's down there. Structures such as salt domes and faults promise oil."

Although the plan is simple, data collection is difficult.

The ship and water are never still. Guns must fire regularly and rapidly without destroying marine life or expending excess energy. Sharks bite cables apart. Sensitive hydrophones pick up stray noises from ocean waves, which blur the signals.

Three or four weeks a year Carol experiments aboard an exploration ship.

"Most of the time I'm using a computer while the crew on the deck tests my equipment in the water. I record data and coordinate sending and receiving signals.

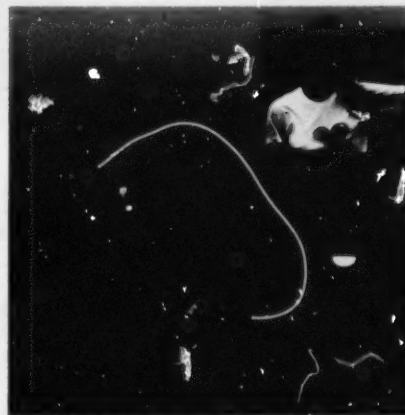
"But when it comes to deck work, I do the same physical tasks a man my size would do. If something doesn't work in the middle of the night, I get up, throw something on and go to work."

Sometimes Carol joins a group that is prospecting on land.

Recently she tested receivers (geophones) in the ground in Wyoming.

What's best about working for a big research company?

"There are many exciting projects going on and I'm free to pursue a variety of scientific interests," she says enthusiastically. "At home my hours are regular and vacations are good. I travel, but not constantly. Even though they're



Carol is a research geophysicist at Exxon Production Research Company in Houston, TX. Her job is to design and improve seismic source and receiver arrays. She sails all over the world testing existing equipment and her proposed improvements.

hard work, my cruises are terrific."

Where did Carol begin?

Carol grew up in Anchorage, Alaska, where she went to public school. "I studied all the science and math I could," she recalls. "I relaxed by playing the accordion, singing in the chorus and girls glee club and doing artwork."

She earned her B.S. degree in physics. Then she took oceanography and geophysics in graduate school.



Carol is the only geophysicist on exploration trips. "Most of the guys treat me very professionally," she says. "If they tease me, I just laugh and keep my good sense of humor." Between trips she analyzes data in her office, publishes her conclusions and speaks at meetings.

"IT'S THRILLING TO DISCOVER STARS THAT NO ONE KNEW EXISTED!"

Dr. Paula Szkody researches close binary stars. "Many sky objects that look like a single star are really binary—two stars circling each other," she explains.

Frequently Paula works with other people. "Astronomy offers good friends and good ideas," she notes.

Stargazing takes Paula to world famous observatories. Among the beautiful spots she visits are Palomar Mountain in California, Mauna Kea in Hawaii, the Kitt Peak National Observatory in Arizona and the Cerro Tololo Inter-American Observatory in Chile. "My trips are fantastic," she smiles.

Close binaries are best observed from observatories in space because they shine brightest in ultraviolet light.

So, Paula utilizes a robot spacecraft, the International Ultraviolet Explorer (IUE), which orbits Earth daily.

At the Goddard Space Flight Center in Maryland a telescope operator radios Paula's commands to the IUE. Returned data appear on a video screen. Paula uses an interactive computer which displays pictures and data for measurements. She can order more information from space immediately if necessary.

For months Paula analyzes processed data and computer tapes in her office. Often she confers with colleagues. She shares insights at astronomical meetings and in journals.

Why did Paula become an astronomer?

Paula was born in Detroit, Michigan. With her four brothers and sisters she went to parochial schools. Science was not taught separately. Sports and service activities filled her spare time.

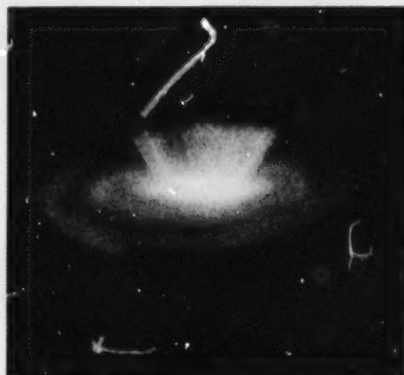
"I took my first real science course at Dominican High School for girls," she recalls. "It was my most interesting subject. Luckily



Part of the year Paula does research and teaches at the University of Washington in Seattle. Then she travels with her husband and daughter to meetings and observatories. She is pictured at Kitt Peak National Observatory's 1.3 meter telescope equipped with an infrared photometer.

no one thought it strange for me to take physics. You need physics to be an astronomer."

Paula first studied astronomy in her sophomore year in college. "I was interested in many things including interior design," she says. "Astronomy seemed most exciting because there are always new discoveries."



"I'm especially interested in strange binary stars called cataclysmic variables," says Paula. "Some radiate huge amounts of x rays and ultraviolet light and change erratically in brightness. Perhaps vast clouds of glowing matter are stripped from a visible supergiant star by an invisible companion, producing the tremendous flows of high energy radiation."

"BIOPHYSICS IS EXCITING BECAUSE I DO SOMETHING NEW EVERY DAY."

Dr. Linda S. Powers probes large molecules that are in our bodies. Her goal is to picture their makeup and to explain how they normally work. This information helps doctors find cures when body processes break down.

"I've studied how calcium binds to muscles when we flex them and how oxygen binds to iron for transport in our blood," she says.

"Now I'm investigating an enzyme called cytochrome c oxidase which acts in the last step in respiration. It converts the oxygen we breathe to water and makes compounds that give us energy."

How can you "look" inside molecules?

The technique is called x-ray absorption spectroscopy. X-ray beams shine like a searchlight onto a tiny sample and electronic detectors collect scattered x rays which reveal their structure.

For a change of pace, Linda enjoys many interests. These include guitar and folk singing, her show West Highland White terrier, black Arabian horses and a scenic Utah cabin where she trail rides.

"I've always combined serious work and play," she confides.

"In grade school in Beckley, West Virginia, I was so fascinated by the stars I got my own telescope. Throughout junior and senior high, I did experiments and built rockets in a lab I stocked in my basement.

My parents encouraged me even though they thought I might blow up our house!"

At Woodrow Wilson High School, Linda took all the math and science courses available and played in the band. After school she worked as a salesperson in a clothing store.

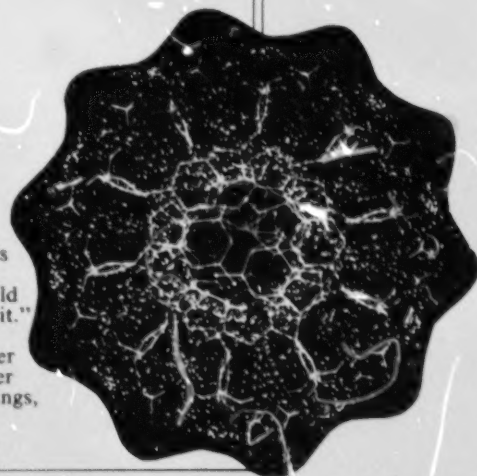
During her senior year she did a project for the Westinghouse Science Talent Search. "My first airplane trip was to Washington, DC, as one of the national winners," she smiles.



Linda designs her experiments in her office and laboratory at Bell Laboratories in New Jersey. Every few months she flies to California to do them on the synchrotron, a big, powerful source of x rays, at SLAC (Stanford's Linear Accelerator Center). Computers record her data which she takes back to her office to analyze.

In college Linda took a B.S. degree in chemistry and physics. She earned enough money as a drummer for a rock band to buy her first motorcycle and travel. Later she completed her Ph.D. in biophysics.

"It's great fun to figure out what the data mean," Linda says vivaciously. "The big payoff is to be the first person in the world who understands it." Frequently she reports her frontier knowledge to other scientists at meetings, in journals and through teaching.

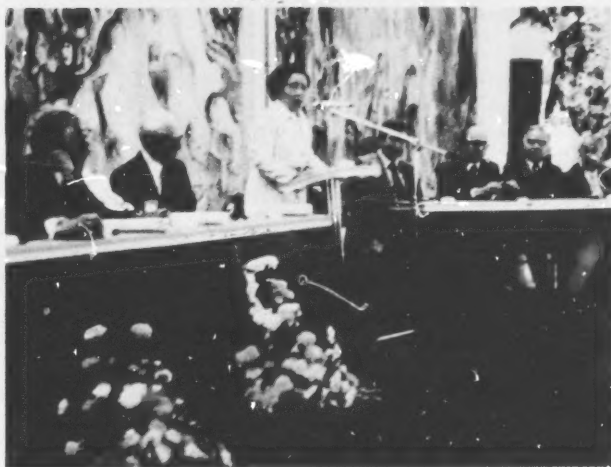


YOUR CHANCE OF SUCCESS IS GREATER TODAY THAN EVER BEFORE.

Policy makers in government, industry, education and science often seek advice from Dr. Mildred S. Dresselhaus. Frequently she serves on their most prestigious action committees. An expert on the physics of solid materials, Mildred directs a research center at the Massachusetts Institute of Technology where she is a professor of engineering.



Dr. Chien-Shiung Wu has earned top awards for her nuclear physics research, university teaching and public service. She was the first woman elected President of the American Physical Society, the national organization of physicists. "Science is a good field because it is objective. You are judged only on the quality of your work," she emphasizes.



Dr. Shirley Ann Jackson was the first American black woman to get a Ph.D. degree in physics. She uses imagination, mathematics and computers to explain basic properties of materials. She travels, speaks, writes and is President of The National Society of Black Physicists. "My priorities are my family and my career," she says.





Dr. Jill C. Bonner ▲ is an active university professor and theorist. She helps young people understand the known laws of nature. Using a computer terminal, she develops mathematical models to explain the unknown. Jill travels around the world to discuss new ideas with other scientists. "I have great moments of creativity and excitement," she sparkles.

◀ Because she had polio, June M. Rooks didn't go to school until she started fourth grade. She was the first handicapped woman to graduate in physics from Jackson State University in Mississippi. Now June works at the Naval Weapons Center in California. She designs computer programs that help pilots and bombardiers fly aircraft and deliver weapons accurately.



◀ A leader in space exploration, Dr. Carol Jo Crannell investigates powerful blasts of radiation from our sun and more distant objects. Her team builds detectors which they send up on gigantic balloons and spacecraft. "Being an astrophysicist, wife and mother is a challenge that makes my life fun and rewarding," she declares.

Dr. Rosalyn S. Yalow ▶ won a Nobel Prize for developing a test now used worldwide to improve health, fight disease and solve crimes. It detects tiny amounts of substances such as hormones, viruses, drugs and poisons in body fluids. "We women must believe in ourselves or no one else will believe in us," she advises.



▲ The pursuit of stories about physics has taken Gloria B. Lubkin to laboratories and meetings across the United States, Europe, the Soviet Union and China. She is the senior editor at *Physics Today*, a monthly magazine. Her specialty is reporting important discoveries and government activities in science.

START TO PLAN YOUR FUTURE.

Think about how your career will fit into the life style you want. Talk to your science and math teachers, advisors and parents about the opportunities physics can open to you.

Go to your public library. You'll find popular books and magazines that tell about current topics of interest in science.

Ask physicists about their work. Companies, universities, laboratories and museums often let people see their facilities and meet their staff. Call to find out when you can visit.

Get a wonderful reading list, useful names and addresses and more information from The Committee on the Status of Women in Physics, The American Physical Society (see back cover for address and telephone number).

YOUR OWN GOALS AND TALENT

will determine how much more science and math you study after high school.

If you want to be a physicist, you must at least graduate from college with a degree in physics.

The most interesting jobs usually require a degree from graduate school.



ACT NOW TO KEEP YOUR CAREER OPTIONS OPEN.

Take all the math and science you can. Math is the language of physics and computers are the main tools for calculations. Understanding high school science will prepare you to enter college and be a good citizen in any job.

Join a science or computer club in your community or start one yourself. You'll find other people who enjoy solving puzzles, exploring nature, doing projects and sharing ideas.

Work on your own projects. If your school has a science fair try to participate in it.

Get experience with tools, electronics and machinery. You may take shop and industrial arts courses or build and repair things on your own.



Inside a fusion device at the Princeton Plasma Physics Laboratory.

Math and science are demanding. They require solving problems and doing laboratory experiments. Think of the effort and time you spend as an investment in your future. Your rewards will be new skills, self-confidence, friends and career possibilities.

"Physics in Your Future" introduces physics and careers in physics to young people, their parents, teachers and advisors.

Although physics is not usually taught until the last years of high school, the necessary mathematical preparation is decided at the junior high school level. The purpose of this booklet is to inspire students who might otherwise avoid technical subjects to take all the mathematics and science courses they can.

The American Physical Society (APS) is dedicated to the advancement and communication of the knowledge of physics. The Society publishes scholarly journals and organizes scientific meetings. It establishes committees, such as the Committee on the Status of Women in Physics (CSWP) to consider issues of concern to APS members.

The CSWP has sponsored a variety of projects including employment studies, career booklets, a newsletter, a roster of women physicists and many symposia at APS meetings.

Author Dinah L. Moche, Ph.D., is a professor of Physics and Astronomy at Queensborough Community College of the City University of New York. Dr. Moche is the author of numerous books and articles that make science accessible and exciting for everyone.

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